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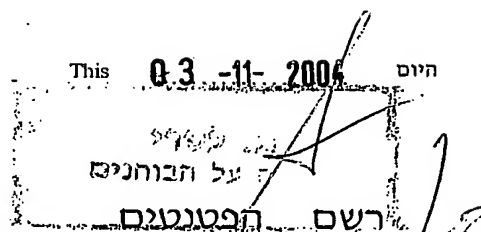
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מספר: Number	158936
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אני, (שם המבקש, מענו - ולגבי גוף מאוגד - מקום התאגדותו)
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CONTINUOUSLY VARIABLE TRANSMISSION

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ממסרת רציפה

CONTINUOUSLY VARIABLE TRANSMISSION

CONTINUOUSLY VARIABLE TRANSMISSION

FIELD OF THE INVENTION

5 The present invention relates generally to transmission of torque and rotation from a motor to driven loads. More particularly, the invention is about a method of transmitting power from the motor to the driving components of vehicles such as cars, ships and locomotives.

10

BACKGROUND OF THE INVENTION

Motors produce mechanical energy in rotational form, from a variety of forms of energy. Typical energies converted by motors are electric energy, hydraulic energy, internal chemical combustion, plasma streams and others.

15 For devices utilizing power from a motor in rotational form, the functional relationship between power (work exerted by the motor per unit time), the torque (T) and rotational rate (rpm) is described in equation 1:

$$1. \quad P = k(T \times \text{rpm})$$

In words, the power is a function of the torque (T) exerted by the motor

20 multiplied by the rotation rate (in rpm) of the motor.

A transmission system is required for matching between the output rotation rate characteristics of a motor, usually measured in rpm, and the requirements of the driven load. Typically, transmission systems contain one or more sets of gears, hereinafter referred to as gear sets which transform one rotation rate into a different rotation rate as specified by physical dimension relations between elements of the gear. Usually, this relates to the ratio between the radius of engaged gears which transfer torque and rotation from one gear to another. The gearing ratio is a single numerical value that describes the transformation ratio of a specific gear set arrangement. Usually however, a specific gear set arrangement sustains more than one input rotation rate value, sustaining rather a range of motor velocities. The motor operates however more efficiently over a more restricted section of the sustainable range. When a desired input rotational velocity is required by a driven load, which lies outside of the permitted range of rotation rates allowed by a specific gear set arrangement, a new gear set arrangement is to be employed. A CVT (continuously variable transmission) differs from conventional transmission in that it can provide a continuous spectrum of gear ratios, rather than a discrete group of such ratios. A motor using CVT is able to almost always operate in its optimum rpm range, permitting more efficient motor function.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a general scheme describing the positioning of a transmission system of the invention;

Fig. 2 is a schematic description of the drive chain of the transmission
5 of the invention;

Fig. 3A is a schematic layout description of a CVT of the invention showing rotation rate modifier capable of restricting rotation of a first shaft of the driving chain with respect to the frame;

Fig. 3B is a schematic layout description of a CVT of the invention
10 showing rotation rate modifier capable of restricting rotation of a second shaft with respect to the frame;

Fig. 3C is a schematic layout description of a CVT of the invention showing rotation rate modifier capable of restricting rotation of a first and second shaft with respect to the frame;

Fig. 3D is a schematic layout description of a CVT of the invention
15 showing rotation rate modifier capable of restricting rotation of a first and second shaft with respect to one another;

Fig. 3E is a schematic layout description of a CVT of the invention showing rotation rate modifier capable of modifying the rotation rate of a first
20 shaft by deriving rotation from the motor shaft;

Fig. 3F is a schematic layout description of a CVT of the invention showing rotation rate modifier utilizing an external power source for inducing a rotation rate change in the branch of a driving chain;

Fig. 4A is a schematic description of a structure of a transmission system of the invention showing the direction of rotation in various sections;

Fig. 4B is a schematic description of a transmission system of the invention showing the direction of rotation in various sections;

5 Fig. 5 is a schematic description of the gear - sets of a transmission system of a preferred embodiment of the invention;

Fig. 6 is a schematic description of a transmission system of a preferred embodiment of the invention including a rotation rate adapter. .

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The system of the present invention is a modified power transmission which mechanically implements a continuously variable transmission (CVT).
5 The transmission system of the invention is intended for use with motors/engines of various kinds. Schematically, this is shown in Fig. 1 to which reference is now made, a power - providing device, typically engine or motor, 40 provides the drive, in the form of torque and rotational velocity. The torque is transmitted by the continuously variable transmission system 42 of the
10 invention and provides torque and rotation to a driven load 44. A power providing device with which the system of the invention may be compatible is any internal combustion engine, any electrical motor, any turbine, hydraulic engine and in fact any rotational power source. At the driven consumer end, the system of the invention may take the form of industrial machines,
15 generators, road vehicles, tractors, locomotives, tanks and troop carriers, helicopters, ships and indeed any rotational mechanic machinery.

Basic architectural features of a transmission of the invention

The continuously variable transmission (CVT) of the invention
20 employs two constant - ratio gear - sets, a first gear - set (hereinafter referred to as gear-set A) that receives torque and rotation from the power provider (hereinafter referred to a motor for all possible cases) and a second gear - set (hereinafter referred to as gear-set B) that provides torque and rotation to a consumer of rotational power. Suitable gear sets for carrying out the tasks of

gear sets A and B of the CVT of the invention are gear sets with three gear elements and attached shafts for inlet and outlet, such as planetary gear - sets or differential gear - sets. The basic structural and functional aspects of such gear - sets are described in chapter 17 "gear trains" of "Fundamentals of Mechanical Design" by Richard M. Phelan, second edition, McGraw Hill, New York, the contents of which are incorporated herein by reference. However any other gear - set of similar characteristics may be employed by a CVT of the invention.

Another essential component of the invention is a gear - set for reversing the direction of rotation and torque provided by gear-set A as will be elaborated below. Additional gears for adapting the rotational velocity are applied for matching the torque provided by gear - set A to the respective gear in gear - set B .

In general, the drive chain of the transmission of the present invention is partitioned into two branches, through gear- set A, such that torque and rotation are transferred in two parallel branches, to be combined again in a combining gear set B. A scheme of the drive chain of the invention is described schematically in **Fig. 2** to which reference is now made. Motor **40** provides rotation and torque to gear - set A **62** which is a torque/rotation partitioning means providing rotation and torque to one inlet gear of gear - set **70** (gear - set B), and to another inlet gear of gear - set B **70**. Gear - set **72** functioning as a rotation reversing gear - set interposed between gear - set A **62** and torque/rotation combining gear - set B **70**. Generally, a rotation reversing gear - set is included in the assembly of the CVT of the invention, as an

independent unit, or in combination with gear set A or B or with any other gear set. Its position may vary within the assembly to perform its task. An additional component of the invention is a rotation rate modifier 74 which transiently exerts a rotation rate modifying effect on the rotation rate of either of the
 5 branches of the drive chain or both.

The three inlet – outlet gears of the respective gear – set A and gear – set B of the invention comply each with the following rules: the rotation rate n in any one gear is a function of the rotation rate of the other gears, thus

1. $n_1 = f(n_2 + n_3)$
- 10 2. $n_2 = f(n_1 + n_3)$
3. $n_3 = f(n_2 + n_1)$
4. Between the torques of specific two gears of each of the above described gear - sets there exists a relationship as follows:
5. $T_1 = KT_2$, wherein T_1 and T_2 relate to gears in the gear -
 15 set.

In words, the torque of one specific gear equals the torque of the second specific gear times a constant. The third gear is in the present invention connected to either the driving motor or the driven load.

To control the overall gearing ratio of a transmission system of the
 20 invention, the rotation rate in the two branches of the drive chain is modified by exerting a transient rotation rate modifying effect on at least one of the branches of the drive chain. The effect of the rotation rate modifier is exerted by either slowing down or speeding up the rotation rate of one branch of the drive chain relative to the other one. Physically, this effect takes place by the
 25 employment of a mechanical means such as a gear - set or any torque transfer

mechanism, such as a belt drive, for increasing rpm or decreasing rpms. A brake system can be used for slowing down the rotation of a branch of the drive chain.

Schematic descriptions of the potential variations existing in this respect are given in **Figs. 3A – F** to which reference is now made. In **Fig. 3A** the rotation rate modifier **74** exerts its transient influence on the rotation rate, typically restricting the rotation with respect to the chassis (or frame) to which the transmission is anchored. In **Fig. 3B** the rotation rate modifier **74** exerts its influence on the other branch of the drive chain. Alternatively, a rate modifier exerts its influence on both branches of the drive chains. This may be done as in **Fig. 3C** by two separate modifiers **74** and **76** or as in **Fig. 3D** by a complex modifier. Such a complex modifier is a secondary variably continuous transmission (VCT) gear – set as known in the art, e.g. a belt drive. If a complex modifier **77** is used, the rotation rate of one branch changes with respect to the rotation rate of the other arm, as described schematically in **Fig. 3D**. In **Fig. 3E** this is achieved by the application of a secondary VCT gear – set, transferring torque and rotation from the inlet shaft of gear – set A to a drive branch through a rotation rate modifier **80**.

Generally, to achieve a rotation rate modifying effect, some mechanical means is used transiently, such that the whole transmission system transforms from one dynamic equilibrium state to another dynamic equilibrium state. Such means may fall into any one of several classes. The modifying means involving the modifying of the rotation of one branch with respect to the frame of the transmission system. Typically this is done by frictionally restricting

the rotation of a shaft transferring the torque from gear - set A to gear - set B. A more complex modifying system is a system in which the two branches are modified with respect to each other. In a third modifying type, as described in **Fig. 3E** above, a modifier containing a rotation transmission means such as a gear - set or a belt is used to modify the rotation of a branch with respect to the inlet shaft of gear - set A. In yet another alternative, described schematically in **Fig. 3F**, a rotation rate modifier **80** uses external power source **82** transiently to modify the rotation rate of at least one branch of the drive chain.

In **Figs. 4A - B** to which reference is now made the rotation directions in various sections of the CVT of the invention are described. In **Fig. 4A** gear - set **62** and gear - set **70** are differential gear - sets. The rotation and torque are transferred from gear - set **62** to a gear - set **70** and to rotation reversing gear - set **72**. The rotation rate of the gear receiving torque and rotation from the motor **40** is n_1 . Further relations of rotation rates associated with the other two gears are as follows:

$$n_1 = (n_3 + n_2)/2, \text{ and}$$

$$n_4 = - n_2$$

As regards the output rotation rate,

$$n_5 = (n_4 + n_3)/2, \text{ and with respect to torque}$$

$$T_3 = T_2 \text{ and } T_4 = -T_2.$$

In **Fig. 4B** the rotation and torque are transferred from gear - set **62** to a gear - set **70** and to rotation reversing gear - set **72**. The rotation rate of the

gear receiving torque and rotation from the motor 40 is n_1 . Further relations of rotation rates associated with the other two gears are as follows:

$$n_1 = (n_3 + n_2)/2, \text{ and}$$

$$n_4 = -n_3$$

5 As regards the output rotation rate,

$$n_5 = (n_4 + n_2)/2, \text{ and with respect to torque}$$

$$T_3 = T_2 \text{ and } T_4 = -T_3.$$

The main mechanical components of the invention pertaining to one
 10 embodiment are shown in schematic terms in **Fig. 5** to which reference is now made. Inlet shaft 90 provides torque and rotation which is utilized by differential gear 92. The partitioning gear 92 provides torque and rotation through two outlets, i.e, outlet 94 and outlet 96. The torque and rotation from outlet 94 are transferred to direction reversing gear 100, receiving torque and rotation at inlet
 15 102 and transferring onwards reversed rotation and torque at outlet 104. Combining gear 106 receives torque and rotation at inlet 108 and at inlet 110. Torque and rotation are then provided to the driven load through outlet 112. The rotation modifying module 116 defined by a broken line 118 includes a secondary CVT which includes a belt drive comprising two pulleys 122 and 124
 20 and a belt 126, for transmitting rotation to outlet 96.

Applying control over a CVT of the invention

To change the rotation rate provided by the CVT of the invention to the driven load, a rotation rate modifier is activated transiently until a new state

is achieved. To activate the modifier a control mechanism is applied to the modifier. Such a control mechanism may be an actuator that engages a secondary VCT gear-set that increases or decreases the rotation rate of one branch of the drive chain. Typically, when one the rotational rate of one branch is decreased, the other branch increases its rotation rate. Another control mechanism is an actuator of a brake system, that decreases the rate of revolution of one branch of the drive chain. The power for actuating the secondary gear or the brake may be of several sources, for example an external power source (**Figs. 3A, 3B, 3C, 3F**), power transferred between the parts of the transmission system (**Figs 3E, 3D**).

As mentioned above, one or more rotation rate adapting gear sets may be included in the assembly of the CVT of the invention, in combination with gear set **72** or as independent units, or in combination with gear set A or B or with any other gear set. The insertion of such gear sets in a drive chain embodying the invention is described schematically in **Fig. 6** to which reference is now made. Rotation rate adaptor **140** is inserted between rotation reversing gear set **72** and between gears et A **62**. Another example is described by the rotation rate adaptor **142** insertion between gear set A **62** and gear set B **70**.

20

Benefits of the invention

A transmission system of the inventions can accept any torque/rpm input range to produce any torque/rpm output range. In this respect the system is therefore limitless within the prescribed working boundaries. Moreover, for

any torque/rpm combination provided by a motor, the system can output any other torque/rpm combination. A preferred embodiment of the invention transmits power from the motor/engine to the driven load entirely by way of shafts and gears and therefore is a very efficient transmission system.

5 Using the CVT of the invention can not only match an exact torque/rpm combination for any consumed power by the driven device, but as result it can keep the motor working in a maximum performance for any given motor torque or rpm required by the driven load. For combustion engines this means that optimum efficiency can be attained, by burning a minimum amount
10 of fuel consumed per unit power used by the driven load. Further, owing to the efficient use of fuel, less pollutants are released into the atmosphere by the oxidation of fuel.

CLAIMS

1. A continuously variable transmission system for conveying rotation and torque from a motor to a load, comprising:

- 5 • a first gear - set for receiving torque and rotation from a motor and for delivering said torque and rotation in two shafts;
- a second gear - set for receiving torque and rotation from said first gear – set in two shafts, and for transferring torque and rotation to said driven load;
- 10 • one rotation - reversing gear - set for reversing the direction of rotation of the rotation associated with one shaft of said first gear - set, and
- 15 • at least one means for modifying the rotation rate of at least one shaft of said first gear – set.

2. A continuously variable transmission system for conveying rotation and torque from a motor to a load as in claim 1 and wherein an additional gear set means is disposed between said first gear set and said second gear set for adapting the rotation rate of said first gear set to said second gear set.
- 20

- 3.

4. A continuously variable transmission system for conveying rotation and torque from a motor to a load as in claim 1 and wherein said means for modifying the rotation rate is applied to one outlet shaft of said first gear - set.

5

5. A continuously variable transmission system for conveying rotation and torque from a motor to a load as in claim 1 and wherein said means for modifying the rotation rate is applied to two outlet shafts of said first gear - set.

10

6. A continuously variable transmission system for conveying rotation and torque from a motor to a load as in claim 1 and wherein said load is a vehicle.

15 7.

- A continuously variable transmission system for conveying rotation and torque from a motor to a load as in claim 1 and wherein said driven load is an industrial machine.

20

8. A method for changing the overall gearing ratio of a power transmission system by transiently modifying the rotation rate of different gears of a same first gear - set, and wherein two different gears of a second gear - set receive rotation and torque from said first gear - set and from a rotation reversing gear set respectively, and wherein a driven load receives torque and rotation from said second gear - set.

25

9. A method as in claim 8 and wherein said transient modification is achieved by using torque from one outlet of said first gear – set to modify the rotation rate of another outlet of said first gear – set.
- 5
10. A method as in claim 8 and wherein said transient modification is achieved by using torque from an inlet shaft of said first gear – set to modify the rotation rate of an outlet of said first gear – set.
- 10
11. A method as in claim 8 and wherein said rotation rate modification is carried out by frictionally reducing the rotation rate of one gear of said first gear – set with respect to a frame of said transmission system.
- 15
12. A method as in claim 8 and wherein the rotation rates of two outlet gears of said first gear set are transiently modified each with respect to a frame of said transmission system.
- 20
13. A method as in claim 8 and wherein said transient modification is achieved by using torque from an external power source to modify the rotation rate of at least one outlet of said first gear – set.
- 25

For The Applicant:

Yoram Ziv

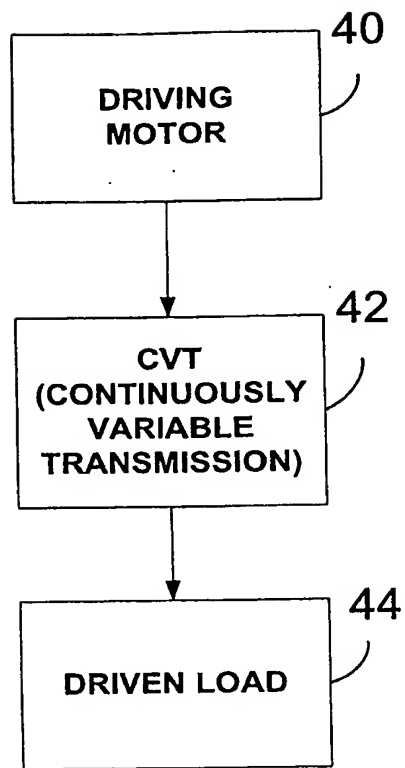
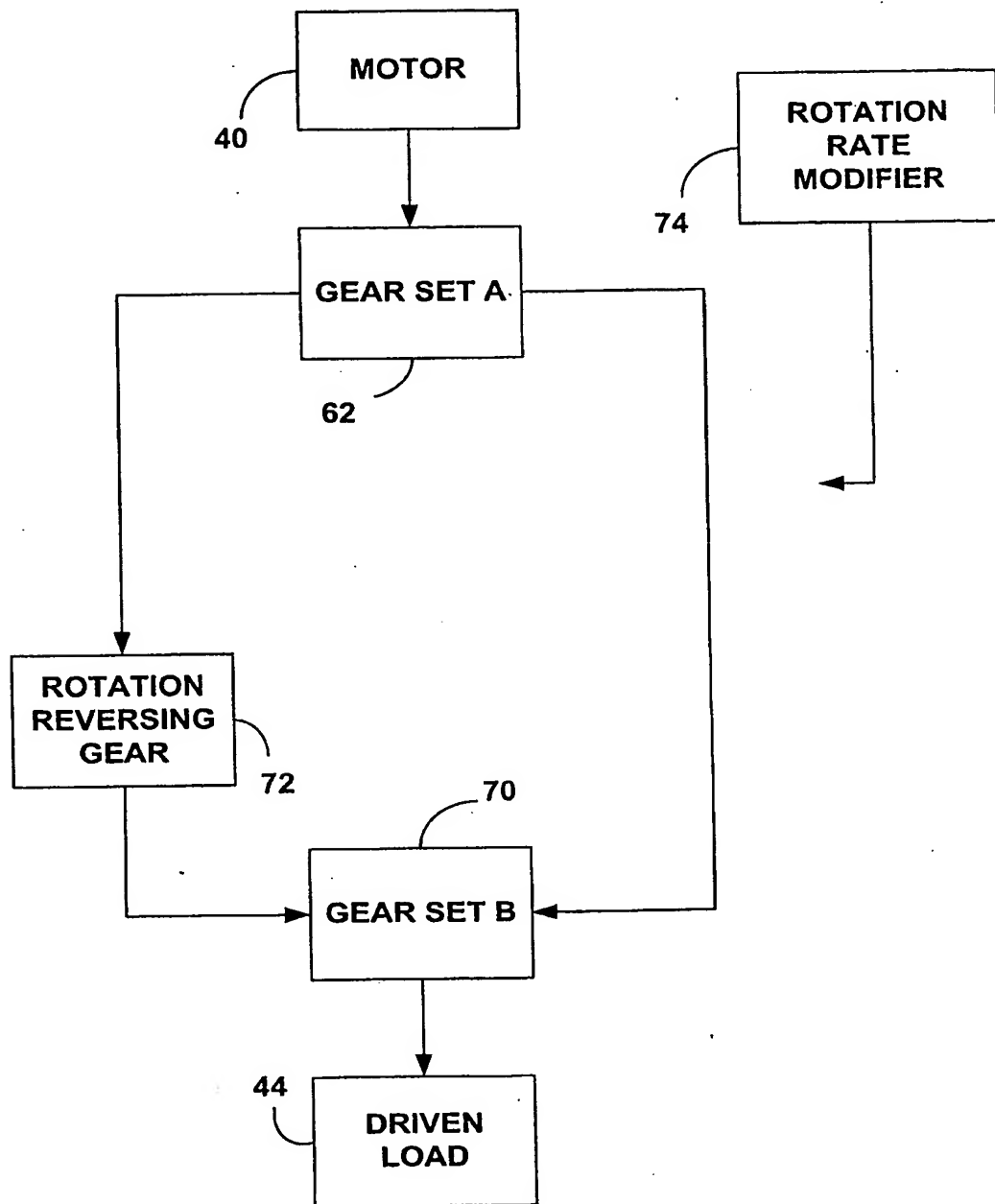


FIG. 1



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Fig. 2

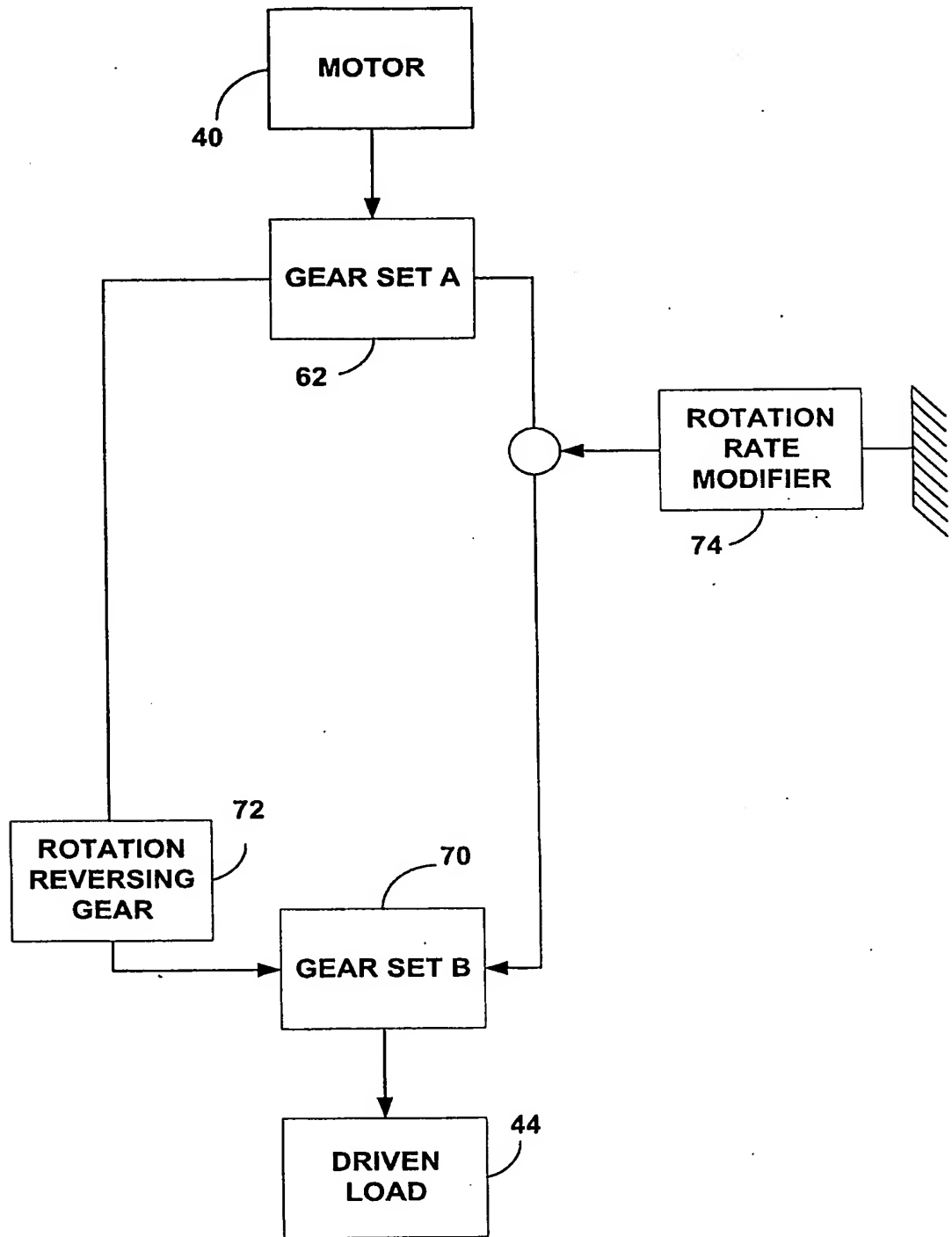
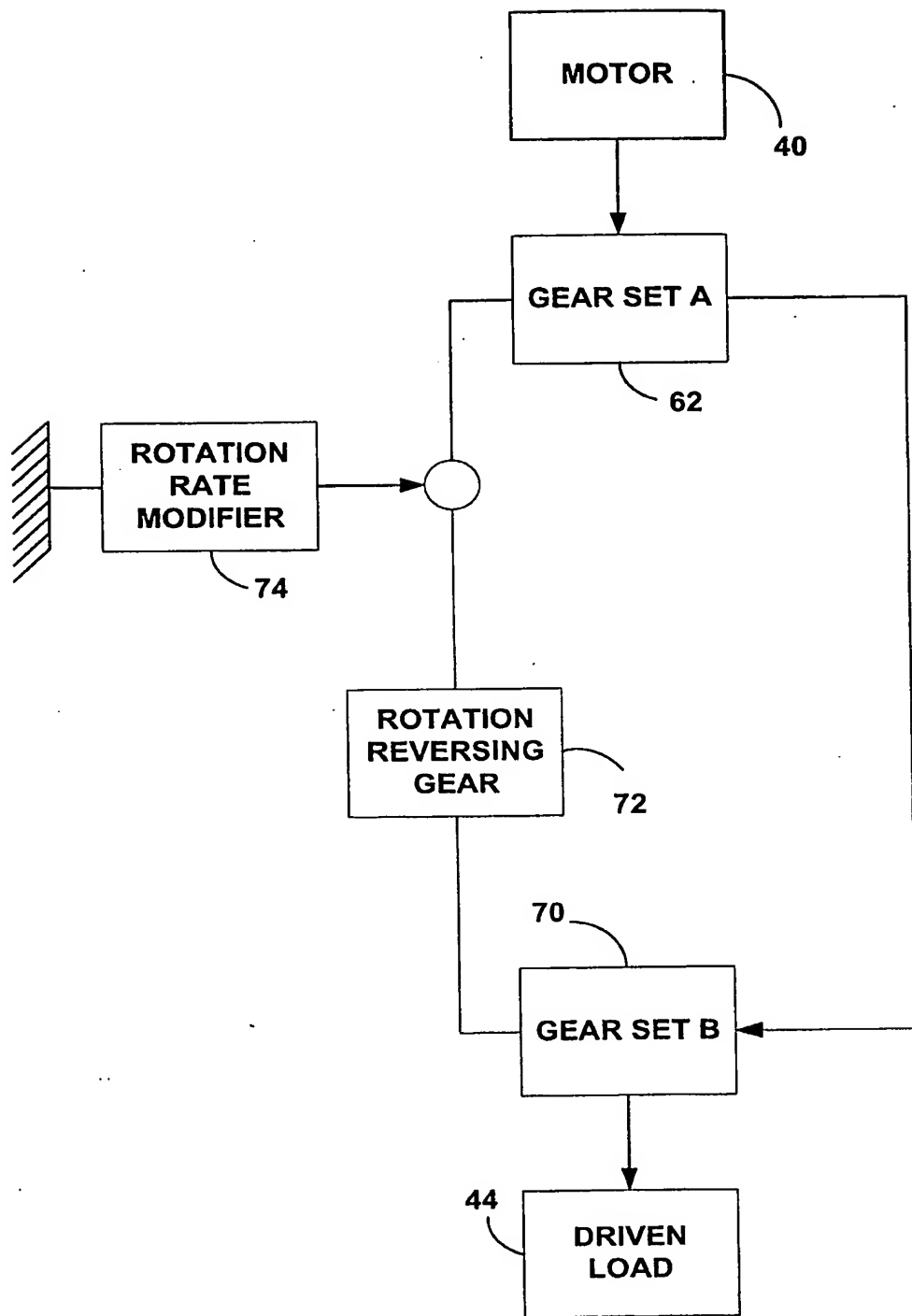


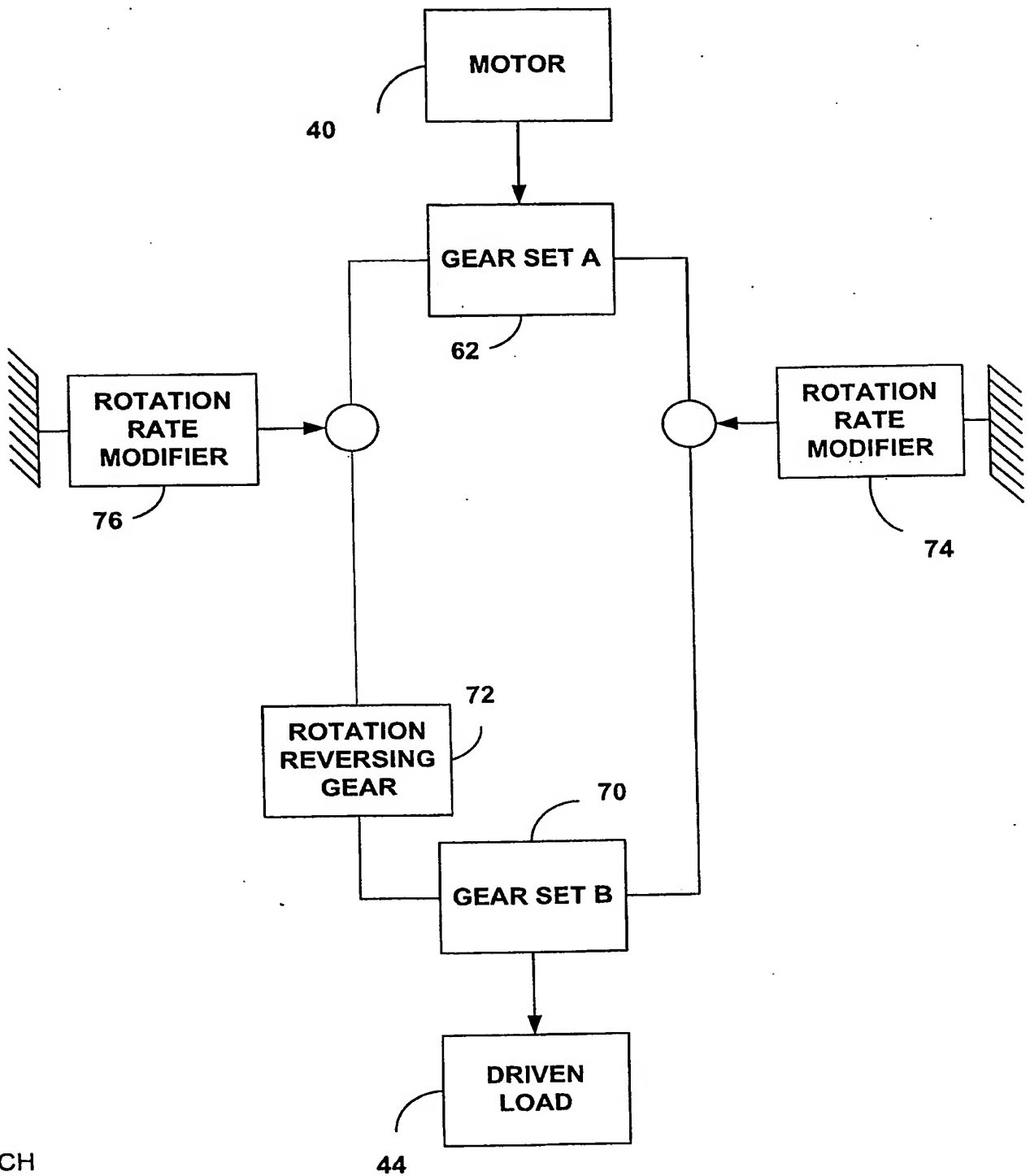
Fig. 3A



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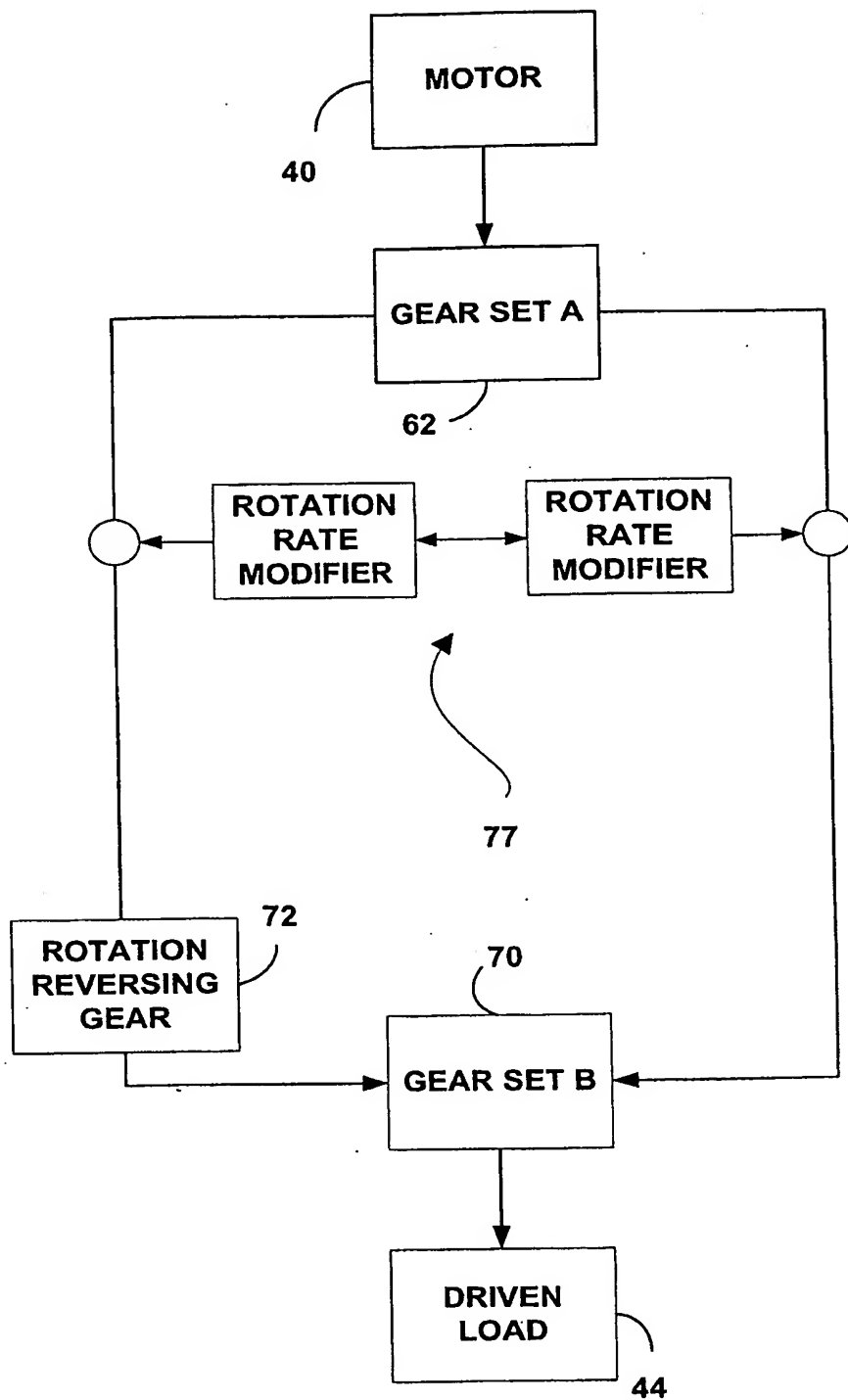
Fig. 3B



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Fig. 3C



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Fig. 3D

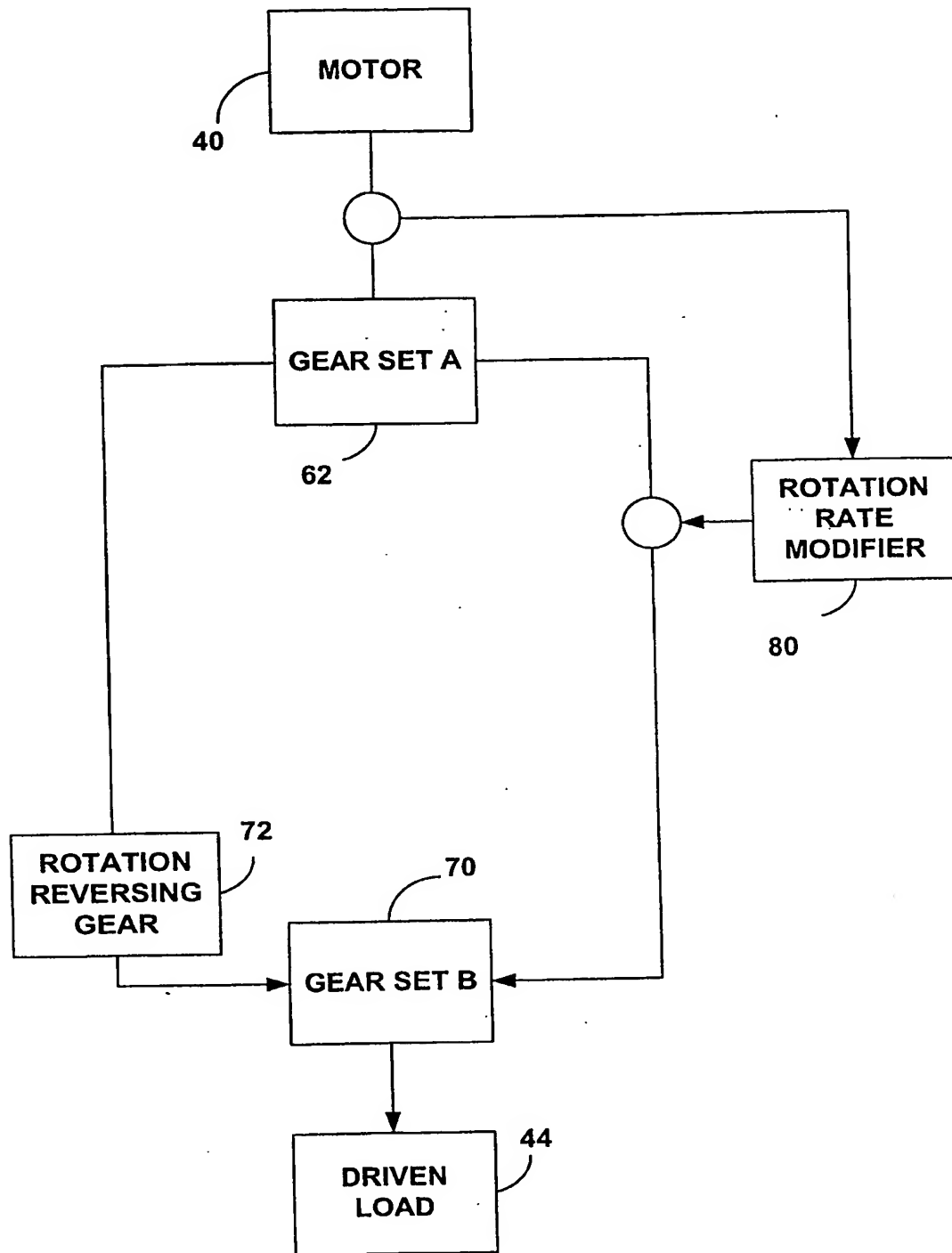


Fig. 3E

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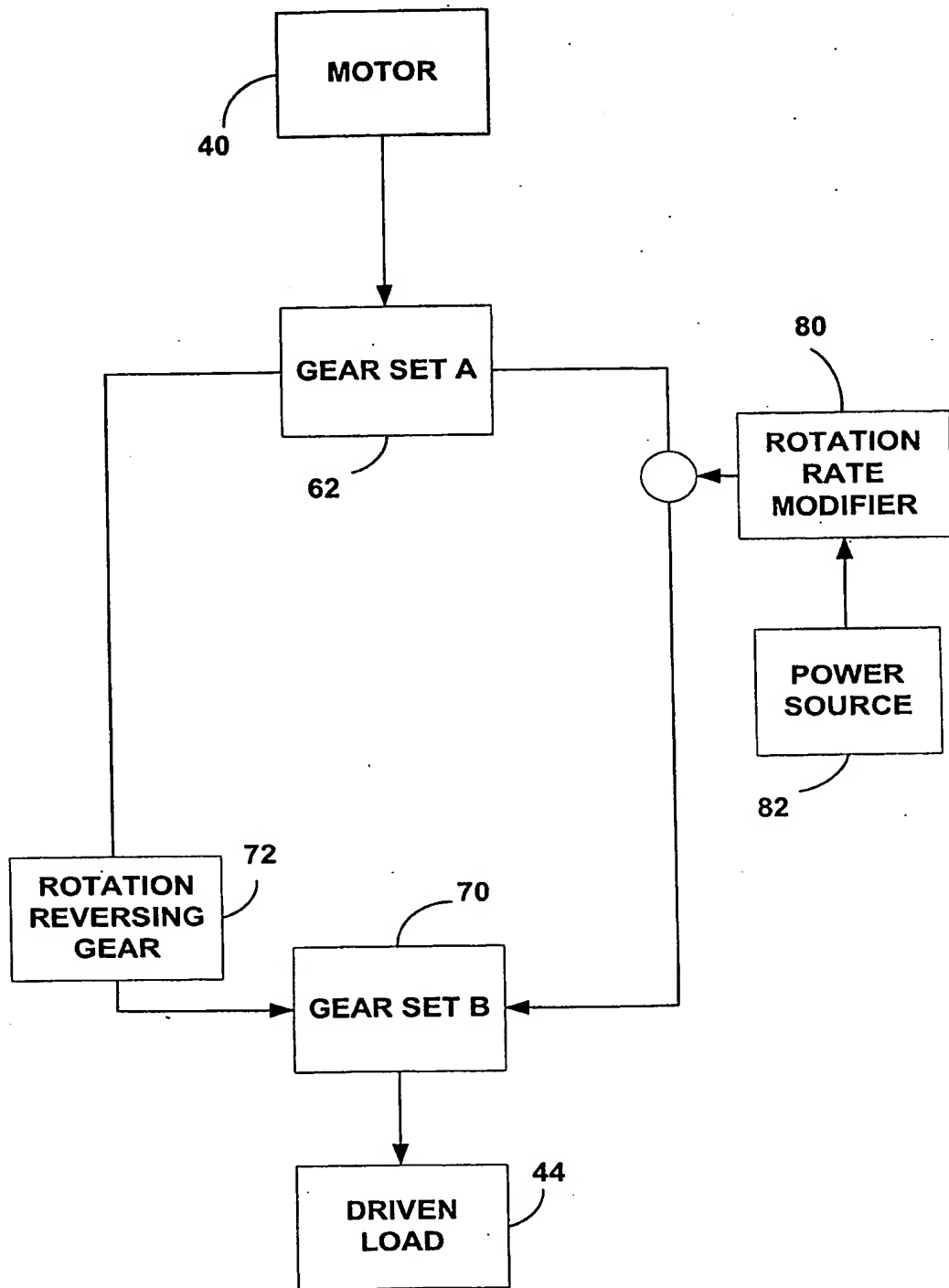
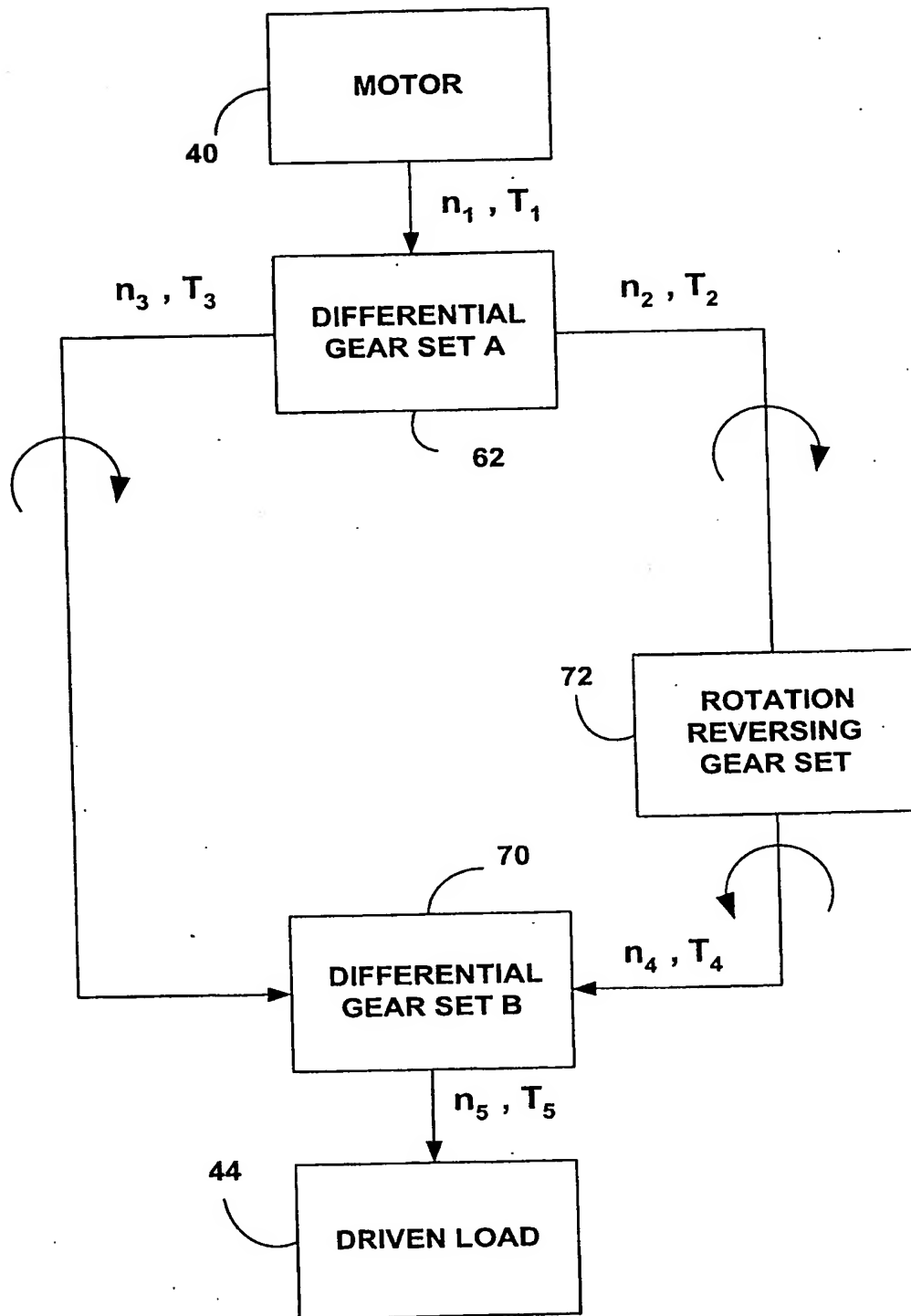


Fig. 3F

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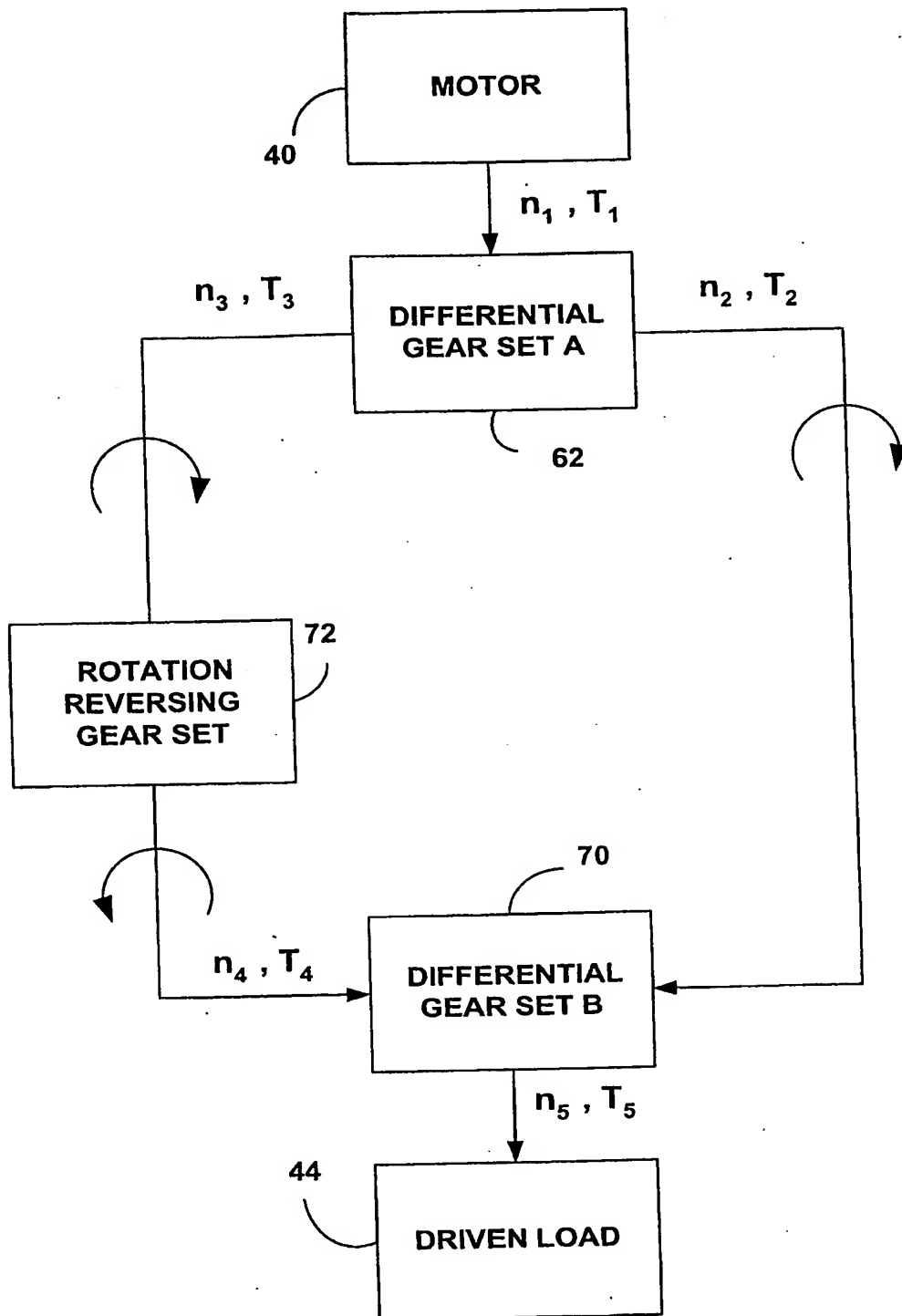
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FIG. 4A

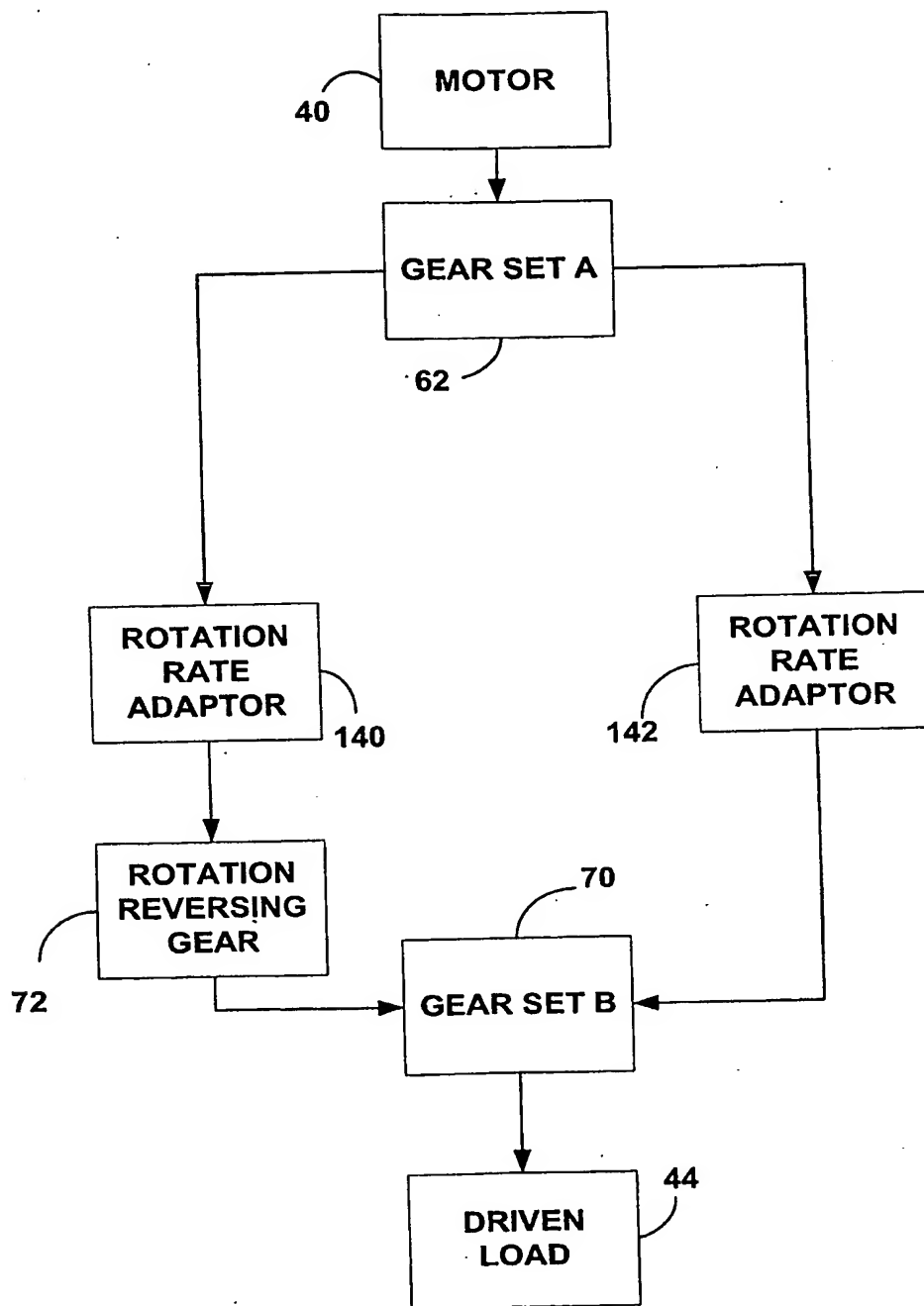


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FIG. 4B

Fig. 5



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Fig. 6